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A Framework for Considering Business Models

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A Framework for Considering Business Models

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Abstract: Information technology (IT) such as computerized physician order entry, computer-based decision support and alerting systems, and electronic prescribing can reduce medical errors and improve the quality of health care. However, the business value of these systems is frequently questioned. At present a number of barriers exist to realizing the potential of IT to improve quality of care. Some of these barriers are: the ineffectiveness of existing error reporting systems, low investment in IT infrastructure, legal impediments to reforms, and the difficulty in demonstrating a sufficient return on investment to justify expenditures for quality improvement. This paper provides an overview of these issues, a framework for considering business models, and examples of successful implementations of IT to improve quality of patient care.

1. Introduction

Information technologies have been substantiated and found to be invaluable in preventing medical errors and improving quality of care and the outcomes of health care. Technologies such as physician order entry, computer-based alerting systems, and electronic prescribing prevent medical errors and improve outcomes, yet their business value is frequently questioned. Demonstrations of the clinical value and cost-effectiveness of information systems are needed in order to justify reimbursement. Also, communication protocols, vocabularies and other essential standards need to be in place for cost-effective interaction among different clinical computer systems and computerized databases. Moreover, a number of additional issues such as rewards for quality improvement, funding to implement systems, and fear of malpractice litigation will need to be addressed. This paper provides an overview of these issues and a framework for considering business models for information technology that can improve the quality of patient care.

2. Quality of Care

The problem of quality of health care in the U.S. was brought to the attention of the public by the Institute of Medicine (IOM) report [1] that estimated that as many as 98,000 people die annually from medical errors. The number of deaths yearly from adverse drug reactions alone exceeds deaths in the U.S. due to automobile accidents, suicides, homicides, breast cancer, or AIDS, respectively [2].

Patients suffer harm for a number of reasons. Studies have shown that about 50% of Americans don't receive preventive care; about 30% don't receive acute care that is essential and necessary; and about 40% don't receive needed chronic care [3-4]. Lack of

needed care presents quality issues [5]. One of the reasons for the lack of care is the fact that 45 million Americans are without healthcare coverage during the course of a year and the number of uninsured continues to rise [6].

Quality problems also arise from the overuse of health services. Studies have shown that about 30% of acute care is inappropriate and about 20% of chronic care is inappropriate for the conditions [3]. Some of the factors that cause this problem are fee for service reimbursement, new technologies that become available, and patient demands for the latest drug or medical procedure (e.g., whole body scans).

A third category of quality issues results from the misuse of health services. Harvard's Medical Practice Study [7] and another study in Colorado and Utah [8] have confirmed an estimate that about one percent of hospitalized patients sustain injuries from negligence. Based on this rate, it is estimated that 300,000 Americans are injured by medical errors each year [5].

3. A Framework for Improving Quality of Care

The IOM report, *Crossing the Quality Chasm*, [9-10] pointed out that we need to address the quality issue at four different levels: the patient level; the small units of care delivery level; the organizational level; and finally the environment level of policy, payment, regulation, accreditation and litigation. The report concluded that "… in its current form, habits and environment, American healthcare is incapable of providing the American public with the quality of healthcare it expects and deserves."

The report goes on to propose changes at all of these levels. At the patient level, improved access to medical information and communication with providers is important. For example, consumers have consistently expressed a desire for e-mail communication with their healthcare provider. But study after study has shown that physicians are not very enthusiastic about communicating with patients electronically. Consumers also want greater participation in decision-making and the management of their own care.

The current system of small unit health care is primarily based on episodic visits. The IOM report suggests that care should be based on a continuous relationship between patient and provider in order to ensure continuity of care. Moreover, professional autonomy and professional control need to be modified to provide patients with far more control over their own decision-making and health care. Decision making, which currently is based largely on individual experience, needs to be based more on evidence. The present system of individual responsibility for safety also needs to be changed to a system responsibility for safety.

The VA system is trying to institute a system-wide "no blame" reporting system to try to encourage system-wide responsibility for safety. Procedures are designed to take away the secrecy that prevails at the present time about medical errors because of fear of litigation, fear of blame, and fear of penalties for the individual who reports or who is involved in medical errors.

The IOM report stresses the need to move from an emphasis on individual professional and institutional care to cooperation among professionals and institutions. At the organizational level, the IOM report proposes that we need changes such as the implementation of best practice standards, greater use of information technology to support clinical decision-making, much more investment in upgrading workforce knowledge and skills, development of effective teams and teamwork, coordination among services and settings, and improved measurement of performance and outcomes,

At the overall environmental level, issues related to financing and reimbursement are problematic. Regulation, accreditation, and litigation also need to be addressed in order to provide more patient safety and improved quality of care.

4. Toward Business Models

Business models for the use of information technology to improve the quality of health care need to address the following questions: What type of quality improvement will be made? Who benefits from the improvement? What are the rewards for improved quality of care? What type of reimbursement system is involved? Who will pay to improve quality of care? [11].

First, we have to demonstrate that information systems designed to improve quality are cost effective. Several studies reviewed in an earlier chapter have demonstrated that medical errors are frequently the result of systems errors rather than isolated events or individual mistakes [12]. For example, a simulation study by Anderson and others [13] indicated that piecemeal implementation of information technology designed to reduce medication errors had limited success, only reducing costs and adverse drug events about four percent. If a more comprehensive system were installed, the model estimated that the system would have reduced adverse drug events by about 28% and saved the hospital about $1.5 million dollars a year. However, further reduction in medication errors that injure or kill patients would require the integration of information technology with the training of personnel to recognize situations that may result in errors; improved reporting, detection and investigation of errors; the participation of clinical pharmacists more fully in the provision of patient care; and the implementation of systems to prevent errors in dispensing and administering medications.

A recent white paper recommends that information technology be carefully tested and implemented to ensure that it will effectively detect and prevent medical errors [14]. The report also recommends that, in addition to the implementation of provider order entry systems and clinical decision support, standards are needed for data and systems, systems need to be designed to communicate with each other, and that concerns about potential litigation be addressed.

Frequently the implementations of information technologies are in the interests of payers but not providers, or health care administrators and not clinicians. Many of the older hospital information systems were designed primarily to support business and administrative applications such as charge capture. Consequently they do not serve clinical needs of providers as well. There also may be conflicts in terms of who will be rewarded if information technology is implemented to improve quality of care and what the rewards are to be. The Leapfrog Group has suggested that rewards for improving quality may involve increased volume of patients or market share for the institution, increased profits, and/or increased recognition by the public. Each type of reward has different appeal to different providers.

Another issue that needs to be addressed is "who is going to pay to improve quality under the applicable payment system?" Based on estimates that the costs of health care will rise as much as 15% each year for the foreseeable future, it is unlikely that employers will agree to pay more for the technology needed to improve quality. Furthermore, consumers are resistant to paying more for their health care. These are critical issues that are going to have to be addressed.

5. Barriers

5.1 Measurement and Reporting of Quality

One of the barriers to improving quality of care is the measurement and reporting of quality of care. The current voluntary reporting system detects only about 10% of errors [15-18]. In order to make progress in eliminating medical errors, health care institutions will have to

move away from a policy of assigning blame and penalizing individuals to programs that address medical errors in a more systemic way. In contrast, a human factors approach looks for ways to change the system to reduce the likelihood that an error occurs. Also, emphasis is placed on detection and intervention before an error can harm a patient. From this perspective, errors can be viewed as a measure of the overall quality of the health care delivery system. Error rates are a measure of the overall system's failures. [19-23].

5.2 Underinvestment in Information Technology

Low investment in systems redesign and underdevelopment of technology information infrastructure is another major barrier. Information technology represents a very significant expense for providers. Hospitals, physicians, and small physician groups won't make these investments unless they can see a significant gain — especially a financial gain — in investing in information technology and a reasonable return on their investment. A recent Leapfrog survey of 241 hospitals assessed practices designed to provide patient-safety [24]. Only 3.3% of the hospitals reported that they currently have installed a computerized physician order entry system at their institution.

5.3 Legal Impediments

Legal impediments are another serious barrier to the use of information technology to improve quality of care [25-26]. Health care providers perceive medical malpractice litigation as a threat and barrier to quality improvement. Defensive medicine results from the fear of litigation. Moreover, errors are significantly underreported, which undermines attempts to identify errors and correct the circumstances under which they are likely to occur. At present, state peer review statutes provide limited protection and generally don't cover inter-institutional cooperation. Greater legal safeguards are needed to prevent the use of information about medical errors in malpractice litigation against individuals and institutions. Several proposals are currently being considered including federal legislation to protect the privacy of data related to patient safety and quality of care [27], enterprise liability that would hold organizations rather than individuals liable [28-29], and a no-fault compensation system [30].

5.4 Return on Investment

Another barrier is the problem of justifying the substantial investments required to significantly reduce errors and improve quality of care [5]. Under the current reimbursement system, health care providers have little incentive to invest substantial resources in detecting and preventing medical errors. In fact, providers are generally compensated for treating patients who suffer preventable complications from their medical care. Furthermore, the public demands freedom of choice and open access to providers and service. Their decisions concerning health plans, providers, and services are seldom dictated by concerns about quality of care.

6. Examples of Successful Business Models

6.1 Computerized Physician Order Entry Systems

There are a number of examples where the cost effectiveness of IT in improving quality of care has been demonstrated. For example, computerized physician order entry (CPOE) can

significantly reduce medication errors at every stage of the process. At Brigham and Women's Hospital in Boston, the implementation of a CPOE system significantly reduced medication errors and the incidence of adverse drug events (ADEs) [31]. The CPOE system provided physicians with a menu of medications based on the hospital formulary, default doses and a range of potential doses for each drug. Physicians were required to enter relevant information regarding dosage, route, and frequency. Relevant laboratory results were displayed when the physician entered the medication order. The system checked for drug allergies and drug-drug interactions. The computerized system decreased the incidence of preventable ADEs by 17%. It is estimated that prevention of 17% of ADEs could save the hospital $480,000 annually [32].

Even greater improvements in patient safety are possible when IT is combined with other measures to prevent medical errors. When a pharmacist participated in patient rounds on the intensive care unit at Brigham and Women's Hospital, the ADE rate was reduced from 33.0 per 1,000 patient days to 11.6 per 1,000 patient days [33]. The hospital estimated that costs were reduced by $270,000 per year.

6.2 Computer-based Decision Support and Alerting Systems

The Health Evaluation through Logical Processing (HELP) system at LDS Hospital in Salt Lake City, Utah, identifies patients who are at risk for adverse drug effects [34]. This is accomplished by continuous monitoring of patient information. Warning signs include: changes in respiratory rate, heart rate or mental state; seizures; anaphylaxis; diarrhea; critical laboratory test results; high or low blood levels of certain medications; pharmacy orders for medications used to treat allergic reactions. When situations that may result in ADEs are detected, the computer system alerts hospital staff to take action to prevent harm to the patient. In 1992, 567 ADEs at LDS hospital resulted in additional costs of $1.1 million. A reduction in ADEs by 50% would have saved the hospital $500,000 [35].

The HELP system also provides physicians with a computer-assisted antibiotic decision support system [36]. The program is designed to provide clinicians with information about the treatment of infections and the use of anti-infective agents when they are ordering medications. The system is linked to the computer-based patient record and makes patient-specific information available. The program presents epidemiologic information and detailed recommendations concerning the appropriate antibiotic and warnings. Studies conducted with the antibiotic decision support system indicated that its use resulted in a reduction of the number of medications and length of time patients received antibiotics, reduction of costs, a decrease in ADEs, and days of hospitalization.

6.3 Public Performance Reports

New York State's Cardiac Surgery Reporting System is another quality improvement program that has proven to be effective [37]. Data on risk-adjusted death rates following coronary artery bypass graft (CABG) surgery is made public for each hospital and surgeon. The program is operated by the New York State health department, which has broad regulatory powers. The department administers a certificate of need program for cardiac surgery and regulates quality in hospitals, managed care plans, and physicians' practices. It sets rates of payment for hospitals. The department collects data on death rates following CABG and publishes risk- adjusted mortality rates.

Evaluations have shown the program to be effective in improving the quality of cardiac surgery in New York State [38]. Hospitals and cardiac surgery programs have restricted the privileges of surgeons with high mortality rates. One study found that in 1992, four years after the program was initiated, New York State had the lowest risk

adjusted mortality following CABG than any state.

Despite the demonstrated effectiveness of the program, the overall impact of the program has been limited [39]. Hospitals have not been motivated to significantly improve the quality of their cardiac care unless they have received adverse publicity from their poor rating. Moreover, there is little evidence that these data on quality of care have significantly influenced the choice of physicians or hospitals by patients and health plans.

6.4 The Leapfrog Group

The Leapfrog Group, a coalition of large American corporations, is promoting three quality improvement practices. These are the use of computerized physician order entry to replace the current system of paper-based ordering of medical tests and drugs, staffing intensive care units with specially trained physicians, and limiting high-risk procedures such as cardiac surgery to hospitals that perform a high volume of these procedures [40]. Empire Blue Cross Association has proposed the initiation of higher diagnostic-related group (DRG) payments for hospitals that meet these three criteria [11]. Under this program, Empire would estimate the savings that result from fewer medication errors and improvements in surgery and the intensive care unit outcomes. A percentage of these savings would be remitted back to the hospital.

6.5 E-prescribing Systems

Temple Physicians, a primary care practice in Philadelphia, adopted a handheld electronic prescribing system in order to control pharmacy expenses and reduce its malpractice insurance costs [41]. Allscripts Healthcare Solutions, an e-prescribing system, was chosen as a tool to boost formulary compliance and reduce medication errors. The software runs on Compaq iPAQ handheld computers. Physicians can access patient data from the group's practice management software, choose a diagnosis for a patient, and select a prescription from a list of drugs that includes approved generics. The software also warns physicians of patient allergies and potential drug interactions among the drugs that a patient is currently taking. The software prints a prescription order with an electronic signature for each patient and can automatically transmit the prescription to a pharmacy. Since the e-prescribing system was adopted by the 80-member practice, there has been a significant increase in the prescribing of generic medications and the practice has negotiated a 10% reduction in its annual malpractice premium.

6.6 Physician-Patient E-mail

Companies including Cisco Systems Inc., Oracle Corporation, Adobe Systems Inc., Cadence Design Systems Inc., and NEC Electronics, plan to initiate a program in which physicians will be paid $20 per virtual visit to answer patient e-mails [42]. Healinx Corporation in Alameda, California is providing the technology. Employees, whose health plans are administered by Aetna Inc and UnitedHealth Group Inc., will be able to ask clinical questions using the Internet. The patient will access the Web site and complete a questionnaire. The system will analyze the problem, recommend treatment guidelines and send the information electronically to the patient's physician for review.

6.7 Telemedicine

A telemedicine program is being used to improve health care for heart failure patients in New Jersey [43]. The Teleheart System uses video and audio monitoring transmitted over telephone lines to check on chronic heart failure patients. Patients put on a blood pressure cuff and inflate it. They also place a stethoscope on their chest. A nurse at a home care agency with a specialized personal computer and speakerphone can read the patient's blood pressure and listen to his/her heartbeat. The patient and nurse can also converse during the virtual visit and can see each other. The system increases productivity and has improved the quality of care provided to patients with heart failure. An evaluation indicated that among 22 patients, who have utilized the system, hospitalization rates have fallen by 64% and emergency room visits have fallen by 92%.

6.8 Medication Bar Code System

St. Marys Hospital Medical Center in Madison, Wisconsin, has installed Bridge MedPoint bar code system that verifies drugs and blood products before they are administered at the bedside [44]. The system verifies the patient, drug dose, time, and route of administration. Nurses scan bar codes on the medication labels or blood products, on the patient's wristband and on their ID badges. Bedside computers linked to the hospital information system verify that the drugs are appropriate for the patient and record the time that the medication was administered. The system also alerts nurses to potential errors caused by drugs with similar names.

7. Conclusion

While there is evidence that information technology, especially when combined with other measures, can significantly improve quality of care, the pace of quality improvement continues to be slow. Newhouse [45] points to a number of factors that make improvement difficult; namely, difficulties in measuring performance, lack of consumer understanding of medical procedures and technology, the rapid rate of change in technology, and payment systems under which providers are not paid on the basis of results. Also rising health care costs will make it even more difficult to improve quality of care in the U.S.

Improvement in patient safety depends in large part on the successful adoption and implementation of information technology. However, there are significant barriers to the introduction of these technologies into practice settings. At present there are limited incentives for providers to invest in information technology. Surveys have shown that only 3.3% of hospitals have implemented computerized physician order entry systems [24] and only 16% of managed care organizations have adopted electronic prescribing [46]. Quality improvement in health care will require not only fundamental changes at all levels of the health care system as proposed by the IOM report, but business models based on demonstrated clinical value and cost effectiveness as well.

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A Systems Approach to Preventing Adverse Drug Events

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Abstract: It is estimated that over three-quarters of a million people are injured or die in hospitals each year from adverse drug events. The majority of medical errors result from poorly designed health care systems rather than from negligence on the part of health care providers. While there is considerable evidence that information technology can be used to significantly reduce medication errors and adverse events, information technology, to be effective, must be implemented using a systems approach. This paper reviews three studies that have used a systems approach to investigate the causes of medication errors and the effectiveness of information technology in preventing adverse drug events. Significant reduction of medication errors and adverse drug events requires systemic implementation of information technology, improvements in the reporting of errors, and integration with other systems designed to detect and prevent errors.

1. Introduction

Studies dating back almost four decades indicate that a substantial number of patients suffer iatrogenic injuries while they are hospitalized [1–5]. More recently the Institute of Medicine (IOM) report [6] estimated that between 44,000 and 98,000 hospitalized patients die in the U.S. each year due to medical errors (IOM). Medical errors rank between the fourth and seventh leading cause of death exceeding deaths from automobile accidents, AIDS, and breast cancer, respectively.

Studies of the incidence and types of adverse events occurring in U.S. hospitals in New York State, Utah, and Colorado have reached similar conclusions. The New York State study found that 3.7% of hospitalized patients suffered adverse events [4]. Adverse events occurred in 2.9% of hospitalized patients in both Utah and Colorado [7]. In New York state 13.6% of the adverse events resulted in the patient's death; in Colorado and Utah 8.8% of patients who suffered adverse events died as a result. The Utah and Colorado study estimated that the total annual cost of adverse events for these two states was $662 million, while the cost of preventable adverse events was $308 million. For the nation as a whole, total cost resulting from preventable adverse events was estimated to be between $17 billion and $29 billion a year [8].

Forty-five percent of the adverse events identified in the Utah and Colorado study resulted from operative procedures. The second most common cause was drug errors, which accounted for 19% of adverse events. The New York State study also found that drug-related errors accounted for 19% of adverse events in hospitalized patients.

2. Medication Errors

Medication-related errors are frequent among hospitalized patients as well as among outpatients. One study found preventable adverse drug events (ADE) in two out of every 100 patients admitted to the hospital [9]. The study estimated that each ADE increased the cost of hospitalization by $4,700. For a 700-bed hospital the increased cost due to ADEs was estimated to be $2.8 million annually, or $2 billion for the U.S. as a whole. One study of outpatients also found a rate of 5.5 ADEs per 100 patients who visited primary care physicians associated with Brigham and Women's Hospital in Boston due to medication-related errors [10].

Estimates of the incidence and consequences of medication-related errors are most likely low since many errors are unreported. Most hospitals rely on voluntary reporting, which may result in the detection and reporting of as little as 10% of ADEs [11–14]. According to the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), the medication error rate is the most important indicator of the quality of the medication delivery system. One study focused on errors made during the dispensing and administration stages of the drug delivery system; errors frequently occur when the drug dose is omitted or differs from the physician's orders [15]. The study found that the current method of collecting data on the types and frequency of medication errors using incident reports grossly underestimates errors. Nine nurses were observed during two consecutive eight-hour shifts. The hospital services included in the study were medicine, surgery, pediatrics and obstetrics. Observed errors were projected for a period of 59,470 patient days. The study found that only 36 errors were reported on incident reports and 84 errors were reported on anonymous questionnaires. On the basis of direct observation the investigators estimated that 51,200 errors would have occurred in dispensing and administering medications over a period of 59,470 patient days.

A second study was performed in an Army outpatient pharmacy [16]. In this study prescription errors were separated from dispensing errors. Dispensing errors included wrong drugs, when the drug dispensed was different from the one prescribed; wrong dosage strength; wrong dose form; and the wrong prescription label. Every prescription filled and every prescription label was examined over a 21-day period. The overall dispensing error rate was 3.8%. Content errors represented 6% while labeling errors accounted for 65% of all errors.

Another study compared the use of retrospective chart review to direct observation in detecting medication errors [17]. Chart review estimated the error rate to be 0.2%. In contrast, direct observation detected an error rate of 9.6%.

3. A Systems Approach to Errors

Traditional approaches to error reduction in health care have emphasized training, guidelines, and sanctions. Medical and nursing education focus on knowledge and adherence to protocols. Errors are treated as individual mistakes or failings and are punished largely by peer sanctions. Ultimately, health care provider errors may be punished through malpractice tort litigation [18].

At the same time there is growing awareness that the majority of medical errors result from poorly designed health care systems rather than primarily from negligence on the part of health care providers. Preventing and reducing medical errors requires attention to ways to prevent errors at each stage of the delivery system. Systemic modifications reduce the overall likelihood that an error will occur and permit detection and intervention before an error causes harm to a patient [19–23]. Several studies that have utilized a system approach to study medication errors are described below.

4. Systems Analysis of Adverse Drug Events

A study was performed to identify system failures that resulted in errors that lead to adverse drug events (ADEs) and potential adverse drug events [21]. Study units included five intensive care units and six non-obstetrical general care units in two hospitals in Boston, MA. Over a six month period nurse investigators solicited voluntary reports from hospital personnel regarding ADEs and potential ADEs daily. If an error occurred, further investigation was undertaken. Each error was classified into one of four sequential stages of the drug delivery system, namely, physician ordering, transcription and verification, pharmacy dispensing and delivery, and administration to the patient. Errors were also classified by the apparent reason the error was made. Also the underlying systems failure was identified for each incident.

The study identified errors that lead to preventable ADEs at every stage of the medication delivery system. The highest percentage of errors that resulted in preventable ADEs occurred during the ordering stage (49%). Errors resulting in preventable ADEs occurred at all other stages as well: transcription (6%), dispensing (4%), and administration (34%) [24]. One percent of all ADEs were fatal; 12% were life threatening; 30% were serious; and 57% were significant.

Sixteen causes of systems failure that resulted in medication errors were identified and are shown in Table 1. Failures in seven subsystems related to the delivery of medications accounted for 78% of the medication errors that occurred. The most frequent system failures had to do with lack of knowledge about drugs. This lack of information frequently led to prescribing errors. Prescribing errors included choice of drugs as well as incorrect doses, frequencies, and routes of administration.

Table 1. Systems Failures Underlying Medication Errors.

System		Percent Errors
1.	Drug knowledge dissemination	29%
2.	Dose and identity checking	12%
3.	Patient information availability	11%
4.	Order transcription	9%
5.	Allergy defense	7%
6.	Medication order tracking	5%
7.	Interservice communication	5%
8.	Device use	4%
9.	Standardization of doses and frequencies	4%
10.	Standardization of drug distribution within unit	3%
11.	Standardization of procedures	3%
12.	Preparation of intravenous medications by nurses	2%
13.	Transfers/transition procedures	1%
14.	Conflict resolution	1%
15.	Staffing and work assignments	< 1%
16.	Feedback about adverse drug events	< 1%

Adapted from [21]

A second major systems failure resulted from the unavailability of patient-specific information at the time that the prescription was written. Patient data such as laboratory test results, current medications, and allergies often led to prescribing errors. The unavailability of this information also prevented pharmacists from correcting or stopping improper medication orders on many occasions.

In a number of instances the allergy defense system failed even when information concerning patient allergies had been included in the medical record. Failure resulted when the manual system used by physicians, nurses, and pharmacists failed to provide allergy

information when it was needed.

Manual transcription of physician orders was another major source of errors. Many hospitals utilize unit secretaries or ward clerks to enter handwritten orders into the computer system. These hospitals generally rely on nurses to verify orders and to detect transcription errors. During the dispensing and administration stages, errors were made because the system for verifying that the proper drug and dose was delivered to the unit and administered to the patient, failed.

Errors also occurred because of the complexity of the system used to track medications from ordering to administration. Sometimes it was difficult to determine if a medication had been administered, discontinued, or changed. This problem was compounded by problems in inter-service communication. Frequently nurses had trouble contacting pharmacists, and pharmacists couldn't reach physicians when questions arose concerning a medication order.

Other errors resulted from a lack of standardization of procedures. Dosing schedules were not standard throughout the hospital. There was no standard system to ensure that medications were delivered to the appropriate place at the proper time for administration to the patient. The location and use of order sheets, medication administration records, and IV supplies varied from unit to unit. Also, information about medication errors and adverse drug events was not routinely provided to physicians, nurses, and pharmacists. As a result, there was little follow-up to prevent a similar error from occurring again on hospital units.

5. Evaluation of Hospital Pharmacy Systems

The Institute for Safe Medication Practices [25] conducted a national study of the ability of hospital pharmacy systems to prevent drug-related errors. The study involved 320 hospitals in the U.S. In order to test the system, a test patient was created at each hospital. Actual prescriptions that had caused serious injury or death to patients were entered into the pharmacy system. The investigators found that the pharmacy system detected only about a third of these errors. Moreover, in a large percentage of cases the system permitted an override without a formal note that this action had been taken.

Table 2. Institute for Safety Medication Practices Field Study of 320 Hospitals.

Systems Problems
Lack of integration between POE and pharmacy systems
Lab system not integrated with medication order system
No link between IV system and medication order system.
No clinical order screening
Rule-based safety enhancement available but not implemented
Complex order entry system
Drug information is difficult to access
System does not prompt for dangerous situations
System does not allow access to previous patient encounter information
System generates hard to read labels
System uses confusing abbreviations

Taken from [25]

The inability of the pharmacy systems to detect errors was primarily due to systems problems. The major systems problems are shown in Table 2. Many hospital information systems are not integrated. Stand-alone systems for order entry, pharmacy, and laboratories make it difficult to detect medication errors that may result in adverse drug effects. The lack of integration also makes it difficult for providers to access drug information as well as

previous patient encounter information at the time that drug orders are written. Moreover, many systems lack the capability to screen orders and alert or prompt health care providers when dangerous situations occur that could cause serious harm or death to a patient. Even within the medication delivery system, the prescribing, dispensing and administering stages are not electronically linked. Also dispensing and administration errors frequently occur when pharmacy systems use confusing abbreviations and generate hard to read labels.

6. Reducing Drug-Related Errors Using Information Technology

Existing information technology has been shown to reduce errors and resulting adverse effects on patients. For example, studies have demonstrated that computerized physician order entry systems that include decision support can significantly improve the quality of medication delivery [26–29]. Also computerized alerting systems have been shown to decrease error rates, delays in treatment, hospital length of stay and costs [30–33]. However, experience with early hospital and ambulatory care medical information systems suggest that major organizational changes are frequently required to successfully implement information technology, especially physician order entry systems [34–35]. Studies such as the one reported above by the Institute for Safe Medication Practices [25] suggest that piecemeal implementation of information systems may fail to detect and prevent errors. Furthermore, physician order entry systems are frequently complex and time consuming. As a result physicians frequently bypass many of the systems and rely on nurses, unit secretaries, and pharmacists to enter orders into the information systems.

Anderson and others [36] developed a simulation model to evaluate the capability of information technology to prevent adverse drug events in hospitals. The hospital studied had implemented the TDS HC 4000 hospital information system that permits physician order entry. During hospitalization, all patient data is entered into the system, creating an electronic medical record. In order to collect baseline data, a clinical pharmacist and medical student reviewed every medication order written during the day and evening shifts on two nursing units over a 12-week period. Errors that were detected were corrected and classified by type and severity. Approximately 15% of errors were made during the prescription stage. Over 80% of errors were made when unit secretaries transcribed physician orders and entered them into the information system. About 2% of errors were made in dispensing and 2% in administering medications.

Medication errors in the above study were classified by their potential severity. Over 70 percent of the errors were classified as problem orders with little potential for adverse effects on patients. Eighteen percent of the medication errors were potentially significant. If undetected and not corrected, these errors could have resulted in adverse effects or inadequate therapy. Six percent of the errors were potentially serious. These errors could have resulted in toxic reactions or inadequate therapy for a serious illness. Four percent of the medication errors were potentially fatal if undetected and not corrected.

The systems model was used to estimate medication errors, adverse drug events, days of additional hospitalization, and the excess costs to the hospital on 14 medical/surgical units over a 12-month period. The baseline run using the systems model estimated the rate of adverse drug events to be 10.8 per 1,000 orders under the current system (Table 3). The associated hospital costs were estimated to be $5,490,000 per year (Table 4). The simulation model was used to estimate ADE rates and associated hospital costs based on five implementations of information technology. These were:

- Provision of computer-based drug information at the prescribing stage
- Physician computer order entry

- A unit dosing system in the pharmacy
- An automated medication dispensing system, and
- A comprehensive information system for medication delivery

Table 3. Estimated Rates of Medication Errors and ADEs per 1,000 Orders by Intervention

Run	Medication Errors	ADEs
Base Line	41.6	10.8
Intervention 1	39.5	10.3
Intervention 2	38.3	9.4
Intervention 3	38.5	10.0
Intervention 4	19.3	10.2
Intervention 5	30.7	7.9

Taken from [36]

Tables 3 and 4 show the results. The model estimated that the various interventions, if individually implemented, would reduce ADEs by 5 to 13%. The largest reduction in errors and adverse events would result from physician order entry. In comparison, the implementation of a comprehensive information system for medication delivery would result in a 28% reduction in adverse drug events. The estimated reduction in annual hospital costs resulting from ADEs is estimated to range from $285,000 to $700,000 when information technology is implemented piece-meal. Implementation of a comprehensive information system is estimated to save the hospital $1,449,000 per year.

Table 4. Estimated Additional Hospital Costs by Intervention

Intervention	Hospital Costs in $1000s
Base Line	$5,490
Intervention 1	$5,205
Intervention 2	$4,790
Intervention 3	$5,076
Intervention 4	$5,182
Intervention 5	$4,044

Taken from [36]

7. Discussion

It is estimated that over three-quarters of a million people are injured or die in hospitals annually from adverse drug events [9,37]. National hospital expenditures resulting from the treatment of persons injured by ADEs while hospitalized have been estimated to be as high as $5.6 billion per year [8,9]. Between 1983 and 1998, deaths due to prescription errors increased by 243% [38-39].

There is considerable evidence that medication errors that result in ADEs can be detected and prevented [40]. Information systems that include physician order entry, decision support, and alerting systems can significantly reduce errors and adverse events that result in injury to or the death of patients. However, information technology, in order to be effective, must be implemented using a systems approach. Many hospitals lack an electronic medical record that is needed to implement most decision support systems. Lack of integration of physician order entry systems, pharmacy systems, and laboratory systems is another barrier to reducing medication errors.

As demonstrated by the simulation model, piecemeal applications of information technology have achieved only limited results in reducing adverse drug events and

associated hospital costs. Moreover, it was estimated that even the implementation of a comprehensive information system for medication delivery would only reduce ADEs and hospital costs by about 28%. Computerized systems are only part of the overall solution in preventing medication errors and ADEs [41,42]. The process of reporting medication errors and ADEs needs to be significantly improved. At present only about 10% of medication errors are reported using a voluntary reporting system. Improvement in reporting will require a system in which persons reporting the error do not fear punishment. Secondly, pharmacists need to be more directly integrated into the medication delivery system at every stage. Brigham and Women's Hospital was able to reduce the ADE rate in the ICU unit by two-thirds by having pharmacists participate in patient rounds with the ICU team [43]. This resulted in cost savings of $270,000 per year. Finally nursing medication administration and monitoring systems need to be improved. This should include bar coding of medications as well as improved labeling and warnings on medications with a high potential for harm to patients.

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Building Support for Health Information Technologies

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Abstract: Despite the increasing role of information technology in health care, its use still lags behind that occurring in other sectors. Factors contributing to this include the complex health care environment and conflicting political agendas. Building political support for information technology in health care depends on understanding the importance of stakeholders and the environment in which they operate. It is important to involve stakeholders early in the process of implementing new information technology in order to identify needs, barriers, and non-starters. Understanding the historical experience of the community and its past attempts at using information technology is also important. Quality of care issues, nursing shortages, cost control concerns, health insurance costs and coverage rates, institutional solvency, and overwhelming paperwork are current problems in the healthcare environment that can hinder willingness to invest in information technology. Ironically, information technology can also help remedy these problems. Impact on workflow, privacy of personal health information, and system reliability, interoperability, and the ease of updating the system can all have political ramifications with regard to acceptance and implementation of information technology.

1. Introduction

In the last few years, the use of information technology in healthcare has grown significantly. However, the health care sector lags behind many others in its use of information technology. There are a variety of reasons for this, many related to the health care environment. Many others, however, are political. This chapter argues that many barriers to the use of information technology in the health care arena can be traced to political agendas. A clearer understanding of health care community stakeholders, the environment in which they operate, and the political issues that concern them can help overcome political barriers. This chapter is intended to identify the necessary ingredients for developing the political support necessary to implement information technology in health care.

I have been asked to speak on the topic of building political support. I have worked extensively in health information technology over the last 20 years. My experience has ranged from building microprocessor devices to leading developing a disease management software system. Currently, I work at RAND's Science and Technology Policy Institute or S&TPI, supporting the Executive Branch's Office of Science and Technology Policy. S&TPI, created by Congress in 1992, is a studies and analysis federally funded research and development center (FFRDC).

I will discuss building support for information technology in the following sequence: first, I define information technology and outline its benefits for health care, and second, I identify the key stakeholders and examine the issues that concern them.